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Proceedings from the Formaldehyde Symposium

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Proceedings from the Formaldehyde Symposium

Sponsored by The American Association of Veterinary Anatomists
Compiled and Edited by PAUL F. RUMPH

Introduction

A Formaldehyde Symposium was held on July 18, 1982 as part of the annual meeting of the American Association of Veterinary Anatomists. The speakers included: Dr. *Ted A. Loomis*, Professor of Pharmacology and Toxicology, University of Washington; Dr. HARRY J. BEAULIEU, Assistant Professor of Industrial Hygiene and Environmental Health, Colorado State University; Dr. MICHAEL J. BLACKWELL, Toxicologist formerly with NIOSH; Mr. BILL GABRIEL[1], Head of Bios Mount Division of Carolina Biological Supply Co; Dr. CALVIN R. FREMLING[2], Professor of Biology, Winona State University and Pamela J. Park. Esq., Staff Attorney, Brigham Young University.

Opening Remarks – PAUL F. RUMPH

In this Symposium we will attempt to provide for the members as much information as possible about formaldehyde. The program is not intended to promote or debate any particular issue. We recognize that differences of opinion and experience will be held.

In 1859, ALEXANDER BUTLEROV prepared a heretofore unknown "Formyl Aldehyde" as a product of an attempted synthesis of methylene glycol. BUTLEROV published an accurate account of formaldehyde solution, formaldehyde gas and formaldehyde polymer. It has been estimated that the production of formaldehyde in the United States in 1978 was 6 billion, 300 million pounds.

Formaldehyde is colorless gas having pungent odor. It is commercially available as an aqueous solution having about 37 % by weight of the gas in water. This solution, known as formalin 100 % or formalin 40, usually contains 10—15 % methylene oxide to prevent polymerization.

Our highly industrial and technical society has discovered many non-medical uses for formaldehyde. It seems that we are surrounded by materials which require formaldehyde for their production. These include: plastics, paper and brewed beverages, smoked bacon and fish, mirrors, comestics, cameras, dyed artificial silk, textiles and starch.

The formaldehyde present in some building materials is receiving attention as a possible health hazard to dwelling occupants.

The medical profession has been equally ingenious at discovering uses for formaldehyde and formaldehyde by-products. It has been used as a general disinfectant, to prevent excessive sweating in the treatment of athletes foot and as a urinary antiseptic. It is used in the manufacture of surgical sponges, temporary skin replacement, aortic graft prostheses, vaccines, antibiotics, vitamins, and other drugs. The use of formaldehyde with which we are most directly concerned today is as a fixative.

Dr. TED LOOMIS — *Formaldehyde Toxicity*

I've been asked to discuss the subject of formaldehyde from a rather basic toxicologic stand point. The toxic effects of formaldehyde may be grouped as either primarily irritations, sensitizations or potential carcinogenic actions. The effects of formaldehyde are dose related and therefore low concentrations produce small degrees of effect, and as the concentration increases the intensity of a particular effect increases. There is no line of demarcation with respect to dosage below which no effects occur and above which all effects occur.

Various concentration zones are commonly encountered. A lower zone is exemplified by urban atmospheres having concentrations well below 0.2 ppm. of formaldehyde. A medium zone is between 0.2 and 0.5 ppm. A higher zone having 0.5 to 2 ppm might be encountered in an industry or even in a anatomy laboratory. In the zone over 2 ppm, clinical effects are very apt to occur in everybody. Some people can smell formaldehyde when concentrations are around 0.1 ppm but they're rare individuals. Everybody can smell formaldehyde in the atmosphere containing 1 ppm of formaldehyde although the odor of formaldehyde may be obvious, on continued exposure an awareness of the odor tends to disappear.

Formaldehyde is a primary irritant and when it comes in contact with mucous membranes it will produce a dose dependent response. Some people complain about running nose, or eyes itching at less than 2 ppm but these irritant effects may not appear until the concentration reaches 3 to 5 ppm. As the concentration reaches 10—15 ppm the irritant effects become intolerable. Some persons show hypersensitivity to irritant effects at low concentrations. For example such people include the very young as well as elderly people that have compromised respiratory systems. This later group includes emphysematous persons, heavy smokers, asthmatics and people with chronic obstructive pulmonary disorders.

Exposure to atmospheric formaldehyde (i. e. vapor) has not been shown to produce „allergic" or sensitization in the form of dermatologic or respiratory problems although dermal sensitization (allergy) has been experimentally demonstrated by application of liquid formaldehyde to the skin in humans.

Some complaints of people exposed to concentrations in the medium to higher range include wheezing, burning eyes, sore throat and skin rashes. These can be caused by exposure to many irritant chemicals. The skin rashes of course could be due to primary irritant or allergic sensitization. Dermal allergic sensitization has been experimentally studied by Epstein and Meiback who showed that about 5 % of all their patients with eczematoid dermatitis showed sensitization to formaldehyde. Current studies in guinea pigs failed to produce systemic sensitization to airborne formaldehyde particularly by the inhalation route.

Primary irritant effects as well as allergic effects are generally reversable when exposure is discontinued. In contrast, formaldehyde has been implicated as a carcinogenic agent in the rat and by inference a potential carcinogenic agent in humans. The experimental carcinogenesis study was conducted for CIIT (Chemical Industry Institute for Toxicology) by the Battelle Laboratories. The study involved exposure of groups of rats and mice to formaldehyde vapor for eight hours per day, 5 days a week for 2 years at the dosage schedule of 0.0 ppm in the air, 2.0 ppm, 5.6, and 14.3 ppm. The results indicate that formaldehyde under these conditions was not carcinogenic to mice. At the 2 ppm level no rats developed cancer. At the 5.6 ppm level, 2 out of 235 rats (a figure that was not significant) developed squamous cell carcinoma of the nasal turbinates, and at 14.3 ppm, 103 out of 232 rats developed carcinomas exclusively in the nasal turbinates. This was a significant finding. No other cancers occurred in significant numbers in the study. Some animals showed metaplasia and goblet cells hyperplasia and those at the 14.3 level showed a continuing purulent rhinitis. Some of the animals in this study after exposure for 24 months were removed from the exposure conditions and it is noteworthy that all of their nasal problems cleared up.

The data from the CIIT study has been used for modeling purposes to estimate the human health hazard associated with exposures to formaldehyde. Any conclusions that can be made depend on the scientific model used. Thus modeling indicates with an exposure to 0.1 ppm that the risk of cancer can be from one in 1000 to one in 10 million.

Based on the various modeling estimates, a college student exposed for two years to 8.3 ppm for 10 hours per week runs a risk between one in 10 thousand and one in 10 million.

Current epidemiological studies do not indicate that formaldehyde is a human carcinogen. For example, high risk populations for formaldehyde such as embalmers do not show an increased incidence of nasal tumors. Also, excellent epidemiological studies on industrial workers with known work-exposure to formaldehyde in the chemical industry show no increased incidence of nasal carcinomas. Of particular interest to pathologists and anatomists is the letter by Jensen and Anderson (Lancet, April 913, 1982) who analyzed the causes of death of pathologists in Denmark between 1943 and 1976 and found no increased risk of lung cancer in pathologists or anatomists as compared to other physicians. Neither did they find any cases of nasal cancer in medical doctors.

Dr. Harry Beaulieu — *Exposures and Monitoring in gross Laboratories*

I'd like to begin by discussing how to sample formaldehyde in an atmosphere containing multiple contaminants. Having as many as 22 available methods to measure and quantify formal-

dehyde in air is one of the reasons for problems in toxicological data. We group the 22 methods into four categories.

The first category is direct reading instruments. These are bazooka-like infra-red instruments that will absorb at specific wave lengths, concentrations of formaldehyde. Because these instruments are not sensitive and won't measure below one ppm, for our purposes they are worthless. Our laboratory studies at Colorado State University show that we need to measure in the .1—.3 ppm range.

Another category includes direct reading instruments, or detector tubes. They are glass tubes containing a solid sorbent that will change color depending on the amount or concentration of formaldehyde in the air. With this method, we have a problem of accuracy in determining the length of stain in the colorimetric indicator tube. These are probably ± 25 % accurate at best. In addition, the instantaneous readings don't represent exposure over a 4 hour laboratory period.

The next category includes six methods that NIOSH and other researchers have promulgated. They are the methods of using solid sorbents. In this group a small glass tube containing a bed of sorbent like acidified charcoal, Alumina, Carboseive or Chromasorb is used to absorb the formaldehyde. You must then take it to the laboratory for analysis. Recently, I discovered three new solid sorbent sampling methods developed for sampling formaldehyde. Two of them are very accurate and adequately absorb formaldehyde onto the surface but they have different analytical techniques. The problems with these are consistency in sampling and the potential for interfering gases.

The basic impinger samplers scrub the air down into a liquid (usually 1 % sodium bisulfite) and chemically trap the formaldehyde. You must then return to the laboratory and perform a colorimetric analysis. There are currently about six of these methods available. Three of them stand out as being accurate. The first and the oldest is the chromatropic acid method. Another is the MBTH method, and the third is called the para rose aniline method. To accurately quantify flow through these sampling devices we have to use a pump and strap it on to people and therefore are not amendable to personal samples. We don't want the exposure in one corner of a laboratory and try to extrapolate it to 80 people in the remainder of the lab. We need personal samples if we expect to get good data.

We are now using a diffusional monitor as a personal sample badge. The badge contains a little piece of paper that has some sodium bisulfite impregnated on it. With it we can determine concentrations from the badge if we know the sampling rate and the diffusion coefficient. Analysis is by colorometric technique.

We have selected the 3M passive monitor because of a first thesis that optimized it as the best method. We also studied the Dupont PRO-TEK and the Palmes (MDA) personal monitors. In the first study we wanted to know how to accurately sample formaldehyde in an environment containing phenol, isopropyl alcohol and the glycol's. Our goal was to optimize a passive monitor and to try to establish an accurate baseline concentration. We used a chromatropic acid impinger, an MBTH impinger for baselines and three of the commercially available passive monitors (3M, Dupont and Palmes MD). One of two environments studied was a chamber with paraformaldehyde as a source of fairly pure formaldehyde. The other was an anatomy laboratory having other contaminants present. The results indicate in that environment the alcohols and phenols interfered severely with the standard method for sampling formaldehyde. We have also concluded that the *3M monitor seems to be the most accurate device for measuring and integrating a persons exposure over a period of time.* The MDA doesn't work. With the Dupont, the precision is poor, the sensitivity is poor and no one can analyze them but Dupont. With the 3M monitor we have good sensitivity, the precision is ok, and its fairly stable. We can hang a badge on an individual and come back a month later to analyze it and not worry about loss in accuracy or precision.

Now I would like to briefly tell you about some of our studies to determine some biological technique of determining exposure. We designed a study using 35 freshman veterinary students (17 males and 17 females). Then for a three week period, we measured their exposure to formaldehyde with individual breathing zone 3M passive monitor badges. We determined each students formic acid in urine before and after. In one sampling week these people, with what I though was pretty poor ventilation were only exposed to about 0.11 ppm on the average. Some were higher, some as high as 0.3 ppm and some lower. The second week of study was about the same. Then working with freshly prepared specimens in the third week, the levels were about 0.04 ppm. In other words it dropped back and approached background. The shift in formic acid in the first week was insignificant and in the second week also insignificant. In week three, it went up with a very low exposure to formaldehyde. From this we concluded that this biological method of monitoring formaldehyd at these levels is not applicable.

When considering the implication of our lung function studies we should examine some work of Dr. Alarie at the University of Pittsburgh with sensory irritants. By objectively determining the

concentration where a rat will decrease his breathing by 50 % (RD 50), Dr. Alarie has determined that RD 50 for formaldehyde is 3 ppm. From this Dr. Alarie is projecting that we need to establish our levels and our threshold limit value at 100 fold below that RD 50 and at the level of .03 ppm you should not see a physiological response. In our lung function studies, we have confirmed that. At the higher levels around .1 ppm we saw dramatic lung function changes but in the third week of the study when the concentration dropped to .04 ppm or .03 ppm we did not see any effect. The toxicological principles have been confirmed. We used 14 very standard parameters for measuring pulmonary function before and after exposure. The students were exposed to about 0.11 ppm in week one, 0.11 ppm in week two and in week three .04 ppm. After exposure to 0.11 ppm we saw dramatic and significant changes in tidal volume. Over a period of three weeks we start to worry because we're starting to imply that maybe this is sustained. In other words there is one potential chronic effect and thats what we start worrying about. We saw similar trends in females with forced vital capacity and in forced expiratory volume. We found acute and sustained tidal volume decreases. Sustained forced vital capacity decreases were all statistically significant. There we've some timed forced expiratory volumes that were potentially decreased. The trends are there but they are not statistically significant. We're seeming to build some potential dose response relationships in lung function changes. There seems to be a trend for the female to respond a little more dramatically. I view the changes in lung function as being significant, measurable and something that needs more study.

Dr. Michael Blackwell — *Government Standards and Exposure Reduction*

The veterinary anatomy laboratory represents an important source of human exposure to formaldehyde. These laboratories contain specimens which are stored in formaldehyde, and significant levels of formaldehyde vapor in the room air would be expected unless adequate engineering controls and work practices are utilized to reduce this possibility. Ranges of exposure will of course vary with duties performed. For years medical science has chronicled the many adverse health effects associated with the exposure of animals as well as humans to formaldehyde and until recently, most known adverse health effects were those of general irritation to the upper respiratory passages, eyes, and skin. Death due to exposure to formaldehyde has been observed in laboratory animals only.

Several investigators have reported basal cell hyperplasias as well as squamous cell metaplasias in laboratory animals exposed to high levels of formaldehyde. Metaplasias are regarded as early evidence of carcinogenic response. Early in the study conducted at the Chemical Industry Institute of Toxicology (CIIT) this was one of the lesions observed in rats exposed to a maximum level of 15 parts per million (ppm) of formaldehyde. Many of these later developed squamous cell carcinoma of the nasal passages.

Now that there is evidence that formaldehyde is causally associated with nasal cancer in laboratory rats, regulatory agencies at all levels are investigating the potential need to make changes in their standards for formaldehyde in order that humans are adequately protected. The results of scientific research have led to various policies regarding an "acceptable level of exposure to formaldehyde".

Exposure Standards

The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) standard for formaldehyde requires an 8-hour time-weighted average (TWA) concentration limit of 3 parts per million (ppm), a ceiling concentration of 5 ppm, and an acceptable maximum peak above the ceiling concentration of 10 ppm for no more than total of 30 minutes during an 8 hour shift. This is the federal law.

These limits are intended to represent a level of exposure to formaldehyde that will not cause any adverse health effects to the majority of people exposed on a regular basis. A "ceiling" is established for those substances that are acutely hazardous at higher levels. This places a definite boundary beyond which concentrations should not be permitted. The regulation allows human exposure to formaldehyde to fluctuate from 0 to 10 ppm as long as the TWA over 8 hours is not greater than 3 ppm, and as long as any exposure above 5 ppm is not longer than 30 minutes, and exposure never exceeds 10 ppm. The current OSHA standard was set prior to any reported evidence of formaldehyde carcinogenicity, and is meant to protect humans from the irritating and immediately debilitating effects of formaldehyde.

In 1976, the National Institute for Occupational Safety and Health (NIOSH) recommended, based upon the irritant effects of formaldehyde, that employee exposure to formaldehyde in the occupational environment be controlled to a concentration no greater than 1 ppm for any 30 minute sampling period. The recommended standard was designed to protect the health and to provide for the

safety of employees for up to a 10-hour workday for a 40 hour workweek over a working lifetime. Although the recommended NIOSH standards is at 1 ppm as compared to OSHA's 3 ppm, it too was set before there was any reported evidence of formaldehyde carcinogencity.

Other standards do exist. The American Conference of Governmental and Industrial Hygienists have recently decided to drop their recommendation from 2 ppm to 1 ppm. Other countries around the world have standards as do some individual states. Most states tend to adopt the federal standard.

In April of 1981, NIOSH published a Current Intelligence Bulletin which was primarily written as a result of the CIIT study and also a study that was conducted at New York University. The CITT findings led to the assembling of a federal panel of experts to investigate the validity of the study, and to make recommendations for needed changes (if any) in the federal regulations of formaldehyde. The panel concluded that: 1) by inhalation, formaldehyde is carcinogenic to the Fisher 344 rat, producing nasal tumors at dose levels that are within the same order of magnitude as those to which humans are exposed; 2) formaldehyde may be carcinogenic to species other than the rat and to tissues other than nasal; and 3) formaldehyde should be presumed to pose a carcinogenic risk to humans.

At present there is not unified federal acceptance of the CIIT study as being justification to change the existing standards. However, until more is known about formaldehyde, it would be prudent for all individuals exposed to it to take appropriate actions to protect themselves from it. There is no known "magical" level of exposure to a carcinogen below which humans will not develop cancer, so therefore much effort should be made to keep exposures as low as is possible and / or practical.

Controlling Exposure

The veterinary anatomy laboratory can be very different from other comparable workplaces in regard to formaldehyde levels in the air. In fact, no two laboratories will probably have the same mean air levels of this substance. Therefore, to control employee or student exposure to formaldehyde, *initial and routine exposure surveys should be made be competent industrial hygiene and engineering personnel.* These surveys are necessary to determine the extent of employee and student exposure and to ensure that controls are effective.

NIOSH advises that employee exposure measurements should primarily consist of the 8 hour time weighted average exposure estimates and that they be collected from the breathing zone samples. You should sample at times that most nearly represent the actual conditions of exposure. This means during embalming and during the actual dissection. There are four basic methods of limiting employee and student exposure to formaldehyde. (These guidelines have been adapted from the NIOSH Current Intelligence Bulletin 34.)

Product Substitution

The substitution of an alternative substance for emblaming and preserving specimens, with a lower potential to cause adverse health effects is an important and possibly the most desirable method for reducing exposure to formaldehyde. Any alternatives to formaldehyde should be fully evaluated with regard to possible adverse health effects prior to selection.

Contaminant Controls

The most effective control of airborne concentrations of formaldehyde is at the source of contamination by enclosure of the operation and/or use of local exhaust ventilation. A gloved hood or a downdraft table may serve as a model for similar equipment and would provide significant protection of the individual.

Employee Isolation

Employees and students should be isolated from direct contact with the area where the cadavers and specimens are stored. The laboratory should be maintained at a greater air pressure than the storage room. Formaldehyde should be stored in securely closed containers. Additional suggestions for the handling and storage of formaldehyde can be found in the *NIOSH: Criteria for a Recommended Standard ... Occupational Exposure to Formaldehyde.*

Personal Protective Equipment

The use of personal protective equipment, which may include respirators, goggles, gloves, etc., may not always be practical. Certainly this equipment should not be used as the only means to prevent or minimize exposure to formaldehyde. Gloves should always be worn when handling specimens which have been preserved with formaldehyde.

Disposal of Formaldehyde

The Environment Protection Agency guidelines for disposal of solid waste do not apply if you have less than 1000 kg/month of formaldehyde and therefore you should dispose of it in the safest way you can. Your state or local regulations may be more specific. If you have more then 1000 kg/month to be disposed of then it must be done by the guidelines suggested for solid waste disposal. This may include inceneration and other methods.

Conclusion

Proper maintenance procedures, good housekeeping in the work area, and employee and student education are all vital aspects of a good control program. Employee and students should be informed as to the nature of the hazard associated with exposure to formaldehyde, its control, and appropriate personal hygiene procedures. Until more definitive information is available, all persons exposed too formaldehyde should regard it as a potential human carcinogen, and respect it as you would any known carcinogen. As health professionals, if we are to be found in error, let it be not negligence in protecting the health of ourselves and the health of others.

Mrs. Bill Gabriel — *Formaldehyde as Fixative and Preservative*

I'd like to talk to you about the properties of formaldehyde, its advantages and disadvantages as in a fixative and preservative. Formaldehyde is one of the simplest aldehydes and it is a gas at room temperature. Formalin is an aqueous solution of formaldehyde (usually 37 % by weight) and it is a poisonous, clear colorless liquid solution with a pungent odor. A fixative is a chemical or mixture of chemicals used to treat biological specimens before preservation so as to retain a reasonable facsimile of their appearance when alive. A preservative is a chemical or chemicals that when added to food, specimens or liquids prevent oxidation, fermentation or other deterioration. This is usually by inhibiting the growth of bacteria and fungi. A 10 % embalming solution of formaldehyde contains one part of the 37 % formalin and nine parts water and so a 10 % formaldehyde solution is actually less than 3 % formaldehyde. We have embalmed tens of thousands of pig embryos, cats, rats, rabbits and dogs. Some are fixed by injecting formaldehyde into the body cavities or tissues. Others are prepared simply by emersing them in the formaldehyde solution. We have over 500 different types of specimens that are initially fixed with formaldehyde. We ship these preserved specimens to colleges and high schools all over the world. When they leave, we have to know that they are thoroughly fixed and preserved because the school may want to use them this term, next year or even later. Over the years we have tried numerous substitutes, but so far none works as well as formaldehyde for fixing specimens. It fixes the tissue right down to the individual cells. When we try a new substitute our check point was always the brain. If the brain is fixed your're in good shape but if the brain is soft and mushy, you are going to have trouble later on. To sum up the main advantage of formaldehyde I would say simply, "it works". Other advantages include that there is little shrinkage of tissue, they retain their normal appearance and it is both a fixative and a preservative. The main disadvantage is obvious and its the reason we are here. Some of the other disadvantages have been pointed out by previous speakers are the running nose, watery eyes, the burning throat and it does evaporate. If you have tanks or vats you are going to have to check them and top them off periodically because it will evaporate. Since we have not found an effective substitute as of yet we still fix all our tissue in formaldehyde and store them in formaldehyde. We ship the specimens in one of two ways. Either in formaldehyde or what we call Carosafe®. Carosafe is basically ethylene glycol which is a preservative. We take a formaldehyde fixed specimen, remove it from formaldehyde, wash it in water, drain and soak in the ethylene glycol. I'm not a chemist but I'm told that the ethylene glycol reacts with formaldehyde and depending on the pH, it forms either hemiacetals or acetals and since there is always an excess of ethylene glycol present, the formaldehyde is reduced to extremely low levels. We are experimenting with fixing whole cats and dogs by embalming using a little stronger formaldehyde in the embalming solution, letting that tissue sit for at least 48 hours and then coming back and under pressure pumping in the ethylene glycol to hopefully neutralize the effect of the formaldehyde.

Dr. Calvin R. Fremling — *Alternatives to Formaldehyde*

I am an aquatic biologist and my research specialty has long been the ecology of large river systems, particularly the Mississippi. Hence, you may wonder why I am addressing veterinary anatomists at this symposium on formaldehyde. I have taught courses including zoology, limnology, vertebrate biology and human anatomy for 24 years. All of these courses and my research involve the use of specimens preserved with formaldehyde. Because formaldehyde is very offensive to me, I began experimenting with alternative methods of preservation in 1959.

I began by reviewing the state of the art of how foods and biological specimens have historically been preserved. Let me briefly review some of these methods. Lowered temperatures retard decay because metabolism is slowed and because frozen water is unattainable to decay organisms. Biological materials can also be preserved by regulating pH. For example, acetic acid and lactic acid have been used for many years to preserve pickles and silage. Scandanavians have historically preserved fish by soaking them in lye solution made from wood ashes. In general, molds and yeasts are the main decay agents at low pHs. Most bacteria do their work best at pHs between 6.6 and 7.5. Few can grow below pH 4.0. Vinegar and many wines, for example, are too low in pH for most bacteria. Similarly, acid fruits are usually spoiled by molds and yeasts, but vegetables and meats are spoiled mainly by bacteria. Biological materials generally keep longer under anaerobic conditions, so we often seal them in jars. In nature, one can see preservation by a combination of all of the previously mentioned methods. The depths of a peat bog are cold, dark, anaerobic, and acid. Fossil remains of plants and animals have remained preserved in such bogs for centuries.

The people of ancient times knew that dehydrated foods such as fish, meat and fruits would keep for years if insects and other animals were kept away. Salting and sugaring have also been effective in making water unavailable to decay organisms. Bees discovered this fact millions of years ago. They store carbohydrates as honey which they fan with their wings to remove excess water by evaporation. The osmotic pressure of the resultant sugar solution is so great that decay organisms cannot extract water from it for their metabolism. For added security, bees seal the honey in wax cells which are not readily biodegradable. As I shall point out later, most of my research has centered around a preservation system which is similar in some ways to that of the honey bee.

Historically, man has employed many biocides such as ethyl alcohol, acetic acid and formaldehyde in his food preparation, embalming and taxidermy. Formaldehyde, for example, has been used for centuries. Early man unknowingly generated formaldehyde by the destructive distillation of wood and used it to preserve smoked meats and fish. Formaldehyde was used to preserve milk until pure food and drug laws prohibited such use. More recently, we have used picric acid, phenol, hexachlorophene, esters of benzoic acid, and pentachlorophenol as preservatives. We have also employed heavy metals such as cadmium, nickel, osmium and mercury.

I began my experiments by screening many solutions, using standard experimental methods with controls and replications. Usually, my controls were specimens which had been fixed and preserved in formaldehyde. Whenever specimens spoiled, they were kept. Thus, I developed a bank of mold and bacteria cultures which were used to innoculate all test specimens. No attempts were made to identify the cultures.

The first compound tested was polyethylene glycol. I found that I could preserve whole organs, fish and reptiles with it. Until freeze-drying techniques were developed, this technique was quite widely used. The technique was published in 1965. My formaldehyde-fixed, glycol-impregnated specimens did not spoil because there was no water available for the agents of decay. I had created a high osmotic gradient condition which was similar to the system used by bees to preserve sugar. Nasco became interested in my work, and sponsored most of my subsequent research on preservatives.

Over the years, I tested many other glycols including ethylene, diethylene, triethylene, propylene, hexylene and others all the way up to 1,6-ethane diol. I also used brines of various salts. I worked extensively with 2-phenoxyethanol and 2-phenoxypropanol and visited the Royal British Museum in London where most of the early work with these compounds was done. Both work very well, but they are prohibitively expensive. I know nothing about their relative toxicities.

I also tested standard fixatives such as FAA, Boin's and Carnoy's. I also tried formaldehyde neutralization with ammonium carbonate wherein formaldehyde is converted to hexamethylene tetramine. This compound is not toxic, but the resultant specimen decomposes quickly. Many biocides were tested including sodium benzoate, all of the parabens, sodium and potassium sorbates, Hyamine, phenol, orthophenyl phenol, pentachlorophenol and various antiodants. From all of this work, it became apparent that formaldehyde is still the single best fixative known. I learned, however, that concentrations of formaldehyde in specimens and in laboratory air could be greatly reduced by employing an alternative preservative solution subsequent to formaldehyde fixation.

Of all chemicals tested, ethylene glycol had the most promise for mass production of biological specimens. After the specimens were fixed in 4 % formaldehyde (10 % formalin), they were washed in water to remove excess formaldehyde. They were then run up through 25 % ethylene glycol which rendered the specimens physiological deserts to the agents of decay. In addition to creating a high osmotic pressure, the ethylene glycol acted as a mild bacteriostat and lowered the vapor pressure of residual formaldehyde so that less of it entered the laboratory atmosphere. Specimens, thus prepared, were flexible and resilient; they stayed moist during prolonged dissections and laboratory exams

because the ethylene glycol served as a humectant. Because less formaldehyde vapors entered the air, light fixtures and sensitive laboratory instruments were not as vulnerable to corrosion.

The ethylene glycol process is not without disadvantages. Ethylene glycol itself is fairly toxic, but its order of toxicity is very low compared to most standard fixatives and preservatives. The lethal dose of ethylene glycol for a human is about 100 ml. The greatest hazard of ethylene glycol is ingestion. There is apparently no hazard via absorption through the skin, or by inhaling vapors from the air. Most of the research done on ethylene glycol toxicity was done in the 1930s when it was proposed as a vehicle for intramuscular injections of substances like insulin. Preservation with ethylene glycol is much more expensive than standard formaldehyde preservation. During the recent OPEC oil embargo, ethylene glycol was difficult to obtain. The single greatest disadvantage to the method, however, is that it requires complex production techniques. Also, ethylene glycol will not readily penetrate thick embalmed animal skins (e. g. dog, cat) so impregnation must usually be done by secondary perfusion subsequent to embalming.

Nasco began marketing ethylene glycol-preserved specimens in 1968, and other companies soon followed suit. Competitors experienced many product failures. To avoid them, some suppliers added pentachlorophenol or its sodium salt to their preservative solutions. Such specimens were distributed all over the United States into the ungloved hands of young people. As you know, most college and high school students seldom wear gloves during dissection because of lessened finger dexterity, expense and clutter. Pentachlorophenol is the second most widely used pesticide in the United States. It is used as an insecticide, defoliant, fungicide and general disinfectant. PCPs are six times as toxic as formaldehyde, three times as toxic as phenol and 60 times as toxic as ethylene glycol. They are mutagenic or at least co-mutagenic and may be absorbed through the skin. Even more toxic than the PCPs themselves may be their contained dioxin contaminants. They too are mutagenic and are less soluble in water than PCPs, thus their concentrations can readily be increased via the food chain. Certainly, PCPs have no place in dissection laboratories.

In summary, formaldehyde still provides the best method of fixation. Subsequent ethylene glycol impregnation provides the safest preservation for dissection specimens. If laboratory instructors do not know what their dissection specimens contain, they should not use them. We should all insist on product labeling which clearly states the ingredients contained in dissection specimens.

Ms. Pamela Park — *Legal Implications*

Not too long ago I picked up a legal periodical with the headlines "Formaldehyde Suits Erupt". The suits dealt primarily with urea formaldehyde insulation problems. It points up that people are becoming sensitive to the possible causation of injury by toxic torts. However, disregarding these insulation cases, there really have not been too many cases in which it has been alleged that formaldehyde has caused injury. But then ten years ago, the same thing might have been said of vinyl chloride or asbestos.

I will not attempt to cover the specific requirements of various statues and I want to limit my remarks to the liability of the laboratory owner or "sponsor" itself or else of the laboratory worker. However, you should be aware that one of the primary defendants in almost every toxic tort case is the manufacturer or supplier of the toxic chemical.

Employer liability for employee injuries is governed almost universally by workers compensation laws. This scheme of relief originated in the early 1900's and every state now has its own version of workers compensation. In order to obtain relief through workers compensation, the worker generally needs only prove that this injury occurred while at work. Some states require that the injury somehow arose by accident. Workers compensation laws significantly changed the philosophies which had previously governed employees claims for injury. Where a sponsor could once argue that somehow an employee had been at fault or perhaps that employee knew of the risk and voluntarily assumed it, these new laws have abolished those defenses. Now as long as causation is proved, liability is generally established.

There are two ways in which this law is going to affect you as employees of the sponsor. First of all compensation is awarded according to set formulas and is almost always much lower than what a jury might have awarded had the case gone to trial. Secondly, workers compensation is the only form of relief against the employer. This is the sole remedy against the employer, but that doesn't mean you can't go against the manufacturer of a product.

As might be expected, all full time employees are covered by the workers compensation. Also part time workers are covered by the act except that a lot of states have an exemption for workers performing out-of-the-ordinary part time services. Students are not normally considered employees but just recently a state court held that football player who was injured in a football game and who was

on scholarship was entitled to workers compensation. This case will probably be appealed but it's something to keep in the back of your mind.

A lot of remedies to students and others non employees are governed by more traditional bodies of law. With few exceptions almost every claim of injury is going to come under the general law of torts. A tort, generally speaking is simply a wrongful act or failure to act which results in injury to someone. Now torts are divided into two broad categories. An intentional tort involves a willful act which results in injury even if the injury wasn't intended. An intentional tort might be when two students engage in horseplay and one gets doused with a chemical in the fight. An unintentional tort involves an allegation of conduct below a certain minimum standard or what we call negligence. By far the majority of claims you might see coming in the context of laboratory injuries will be couched in terms of negligence. An abstract legal definition would be that negligence is a violation of a duty to use due care. Reasonable care, which is another word for due care, is determined by the individual facts or circumstances and is commensurate with the forseeable risks of whatever you're doing. In other words a normal, reasonable, prudent person would be more careful as the risks increase and the higher the risk goes the higher the standard. What we have basically is a prudent man standard.

Before a court can find a violation of a duty, they first have to find a duty to violate. The issue is, do we have a duty and to what extent is that duty? We all have a duty to take reasonable actions to avoid injuring someone. The question is, "How far does our duty go?" Sometimes the appropriate level of care is defined by a statute such as the one Mr. Blackwell discussed. If a sponsor, that is the owner of the laboratory, is subject to a statute and if that statute was designed to prevent a particular type of injury, then possibly, violation of that statute may automatically constitute negligence and automatically impose liability. Now if you are not subject to a statute, for example you are a state entity, you are not subject to OSHA and your state has no equivalent OSHA that you are subject to, no one is going to come in and say you are automatically liable because you violated OSHA's recommendations. Mind you they will try to introduce it to evidence, as evidence of what is safe, but you have the right to come in and say; "Here is our information and we reasonably believed according to current standards that this was not dangerous."

Violation of a statute is not always negligence although at other times it is automatically negligence. But even absolute adherence to statutory standard may not be sufficient to meet the duty of due care. In a case where causation was not at issue, a court imposed a higher standard than the statutory standards. It basically reasoned that because the plaintiff might have been overexposed prior to the time the standards were promulgated it might have been negligent for the corporation to stay just below maximum levels. It should have had an obligation, perhaps, to stay at the very minimum levels.

Besides statutes, another source in defining due care is the common law which consists of legal decisions that accumulate to demonstrate or define responsibilities among individuals. The common law has established that the scope of due care differs with the status of the plaintiff. For example there is one duty owed to a trespasser and there is quite another owed to people like students and others who are invited into the laboratory. An examination of case law indicates that at the very least a sponsor or a laboratory owes to each person allowed upon its premises a duty to prevent unreasonable risk of harm and to warn of dangers to safety which are not obvious so the individual may act prudently. In applying a duty to prevent an unreasonable risk of serious bodily harm, several courts have premised liability on the failure to take adequate protective measures including proper ventilation, proper monitoring of airborne levels of particular chemicals and adequate protective gear. The courts do not expect you to perform miracles or to take prohibitively expensive protective measures. What they expect are reasonable steps and perhaps the best measure of reasonableness is industry custom. In order for a plaintiff to prove that you have somehow violated a duty, they usually must prove an industry standard or, in other words, what other laboratories using formaldehyde are doing to protect their people. You may be held liable if you fall below that standard.

Now the courts also do not expect laboratories to protect against unknown dangers but ignorance is not bliss. You are expected basically to keep up with current developments within your field. In another case, the plaintiff claimed that she had developed chronic dermatitis from working with a powder containing formaldehyde. She sought to introduce into evidence several medical journal articles which indicated the effects of formaldehyde and skin contact. The court held that the duty of due care did not include responsibility on the part of the defendant to run out and read all of the medical journals. Instead the standard was measured by the scientific information known to people of general education and information that has been disseminated throughout your trade. This case illustrates that the law expects you to take reasonable steps to stay current with your field.

One more case will illustrate the parameters of protecting from known danger. Some cement company employees sued their employer for failing to provide good protective equipment. The

company provided approved dust masks that apparently had a tendency to slip out of position. However, the plaintiffs could not show that any one had ever told their employer the masks didn't fit. Thus, the court determined the defendant company could not be held liable for failing to discover a defect.

You also have a duty to warn or educate people of reasonably forseeable risks and the warning must be specific enough to allow people to protect themselves. Basically the warning should allow a person to step back and say "do I really want to incur the risk and if I do what can I personally do to protect against it?"

You can't be expected to anticipate quirky or idiomatic injuries. You *can* be expected to be aware of what some of the effects have been. In the case of formaldehyde, these might include contact dermatitis, local irritations and possibly cancer. You are expected to warn people of that, but not to foresee the unforeseeable. It *doesn't* mean you don't have the duty to react, and fairly promptly, if you see an abnormal reaction taking place.

Besides the duty to protect against unreasonable risk, besides the duty to educate and forewarn, you also have a duty to supervise. A failure to supervise has extremely narrow application. The court is not going to imply an obligation on you if you dont't have supervisory responsibilities. You also have to be fully aware of what is going on or be able to reasonably anticipate it. Laboratory supervisors are expected to take reasonable steps to prevent incidents like horseplay from happening. At least one case has held that the duty to supervise may also include the duty to promulgate and enforce reasonable safety standards.

I want to talk for a moment about miscellaneous considerations in determining liability. The sponsor is liable for the actions of its employees when these actions are within scope of the employees responsibilities. The scope of employment would include anything reasonably in furtherance of the job responsibility. It would not normally include purely private research, even if you are using the laboratory facilities. The sponsor may be named as a defendant and may be liable, but if that liability is based solely on the unauthorized use of its facilities the liability is derviative (or based on another's wrongful act). It is well settled that the sponsor held liable on a derivative basis then has a right to come against the person who was actively wrongful. If there is a wrongful act while you are simply doing your job then the sponsor is liable not on a derivative basis but directly.

Another consideration in establishing liability concerns agency law. Every person employed by a sponsor is an agent for that sponsor. A ruling principle of agency law is that all information discovered or which should be known by an agent is imputed to the sponsor. Therefore I have a duty to keep current with legal developments so that I can keep my university in compliance with laws and regulations. The same thing applies to you with the knowledge within your own responsibilities and area of expertise. It doesn't mean that you have responsibility for legal matters. Counsel for your sponsor has responsibility for legal matters.

In summary then, legal liability may arise under several conditions and differs according to the status of the plaintiff. If the plaintiff is an employee then we are looking at workers compensation and basically the worker need only prove causation. If the plaintiff is an non-employee, a student or someone else who is invited onto the premises, liability is generally almost always established under torts, under negligence. Before you can find negligence you have got to find and define that duty of due care. Cases and statutes help define just how far that due care goes but it is not all inclusive. The prudent man standard applies. A layman's definition of the prudent man standard is "what would a person concerned for their own safety do?" But scientists are known for sort of a devil-may-care attitude for thir own safety so I give you another standard. If you act as though your children were going to spend the rest of their lives in that laboratory you ought to be on safe grounds. Thank you.

Comment and Questions by Dr. EVANS:

You say reasonable steps should be taken to protect people and I agree, but we need reasonable standards based on facts. The danger I see in the present formaldehyde scare is that NIOSH and OSHA are proposing standards for formaldehyde that are not soundly based. We have heard today that we have poor tests, uncontrolled animal experiments, and statements about carcinogenicity that have no basis in the human case. What's bothering me now is that we're being over regulated in some sense. The regulators don't even know what they are doing and we've got to promulgate and enforce some reasonable standards. We had this come up in our school due to a sudden interest in the potential danger of formaldehyde so now I'm asking that all employees in the Department of Anatomy read the booklet called "Toxic Substances in Teaching and Research Laboratories". It was published by the American Association of Anatomists and outlines what precautions should be taken in the handling or inhaling of toxic and possibly carcinogenic substances in our teaching and research laboratories. Do you think that is a reasonable approach?

Ms. PARK:

I think what you've done is to fulfill your duty to warn. As far as your concern about OSHA and NIOSH and other regulations, in very rare instances will they be conclusive. The court would probably look to see whether or not you had a basis for believing that what you did was within known safe levels, and that you had investigated possible harm. If you have no reason to suspect that it is going to be harmful then you should stand on safe grounds, OSHA and NIOSH not withstanding.

Question:

Is it reasonable to request students to read a statement saying that in your training you might encounter certain hazards?

Ms. PARK:

I think so. What I like to see is a written statement with that student having signed at the bottom.

Question:

If we offer students reasonable methods for protecting themselves and they choose to ignore them how do we stand?

Ms. PARK:

If the warning was clear, with college students, the legal doctrine of assumption of the risk should apply. Assumption of the risk does not apply in workers compensation, but it does apply in other situations which would include students.

Question:

When considering the duty to supervise and react, what if students in the laboratory refuse to wear protective clothing? Is there any altered liability for the supervisor who chooses not to tell them to either wear the gloves or get out?

Ms. PARK:

I think it would depend on the level of the student but generally if you can prove that you took reasonable steps, I don't think you have to tell them to wear the gloves or get out.

Comment by Dr. MEYER:

At Ohio State University for $30 per year we can carry 1 million dollars of liability insurance. I would like to encourage any one who does not carry liability insurance to do so.

Comment by Ms. PARK:

I've never seen a case in which an instructor has been held liable especially to that tune. Remember that primarily it is the sponsor or the institution that is going to pick up that tab.

Question:

Are state universities subject to federal regulations?

Ms. PARK:

Not too long ago the supreme court stated that the federal government did not have the right to tell a state government how to run its own business. A state university falls within the business of a state. As far as regulations like OSHA are concerned, they do not apply to state universities because the state university is an entitiy of state government.

Question:

I suspect everybody in this room operates at variance with regulations, do we need to close up shop until all problems are resolved?

Ms. PARK:

It depends on how quickly you can react to the problem. If you've got high levels, you can start taking some temporary measures to limit exposure.

Question:

Do we as professionals have an obligation or duty to establish some standard in reference to exposure to formaldehyde in our laboratories over which we have supervision?

Ms. PARK:

You have an obligation to follow reasonable industry practices. I don't think that it includes setting your own standard.

Comment from the floor:

The American Association of Anatomists has put out a booklet and they have sent that booklet to every department of human or veterinary anatomy in the country. We have said that we will

publish the proceedings of this sympqsium under the sponsorship of the American Association of Veterinary Anatomists so that document will in a sense become part of the record of the professional consideration of a standard.

Question:

Are we responsible for knowing what exposure levels for formaldehyde are in our students laboratories? I have no idea, in terms of parts per million, what the levels are in our laboratory.

Ms. PARK:

If standards are imposed or if standards are recommended throughout an industry, that for instance reliable information indicates that 3 ppm is dangerous, then the duty does arise for you to find out whether or not your laboratory is staying within those basic standards. You have a responsibility to monitor but all you can do is take reasonable measures. You're not required to go out and find the absolute best and most expensive method as long as you believe that you are doing the proper thing.

Dr. BEAULIEU:

I think we need to prioritize problems. You can monitor and document your exposure so that you know what people are exposed to, and then can determine the effectiveness of whaxtever control techniques you apply. As industrial hygienists we maintain that we attempt to keep the exposure to the air borne contaminents as low as we reasonably can achieve.

Question:

I'd like to ask Dr. LOOMIS, Dr. BEAULIEU and Dr. BLACKWELL what exposure levels would they like to see now in the veterinary anatomy laboratory in which their son or daughter was a student?

Dr. LOOMIS:

I would feel very comfortable if the concentration was below .5 ppm and I wouldn't feel uncomfortable if it was 1 or 2 ppm as something like a time weighted average. This is because I'm not concerned with whether somebody has a little irritation of the eyes or throat. That individual should be given special care and let them avoid exposure as much as possible.

Dr. BEAULIEU:

I'd like to maintain the philosophy of the American Conference of Governmental Industrial Hygienists. We should attempt to control the exposure to any of these chemical stressors as low as we possibly can. Based on information from studies that suggest that you have physiological changes that are probably adverse at very low levels, and Dr. ALARIE's suggestion of threshold limit values in the range of 0.03 to 0.3 ppm, I believe that I wouldn't want my kids to work in the laboratories in the state they are now.

Dr. BLACKWELL:

I think that I would want my child in an environment where those levels are as low as is practical or possible. As far as the philosophical discussion goes, they would be meaningless to me if that child later developed a problem. Who can tell us for sure that the response that we would see in humans is going to be nasal cancer. We know that humans are not obligate nasal breathers like rats are. So there is a tendency to bypass nasal turbinates. Who can tell us for sure that the agent doesn't do something else to our bodies and some of the other problems we are seeing aren't in fact related.

Question:

Would you help us look at our situations and tell us what positive measures you feel are essential to ameliorate the vapor concentrations of formaldehyde and secondly what kinds of personnel protection should one use to complement whatever environmental changes we bring about?

Dr. BEAULIEU:

We should prioritize the problems. Determine where the greatest exposures are. For instance when classes study the central nervous system and use a brain soaking in formaldehyde, those are higher exposures. The key is to determine where your problems are the worst and to deal with them first. As an industrial hygienist, we recommend substituting less toxic materials. Using the glycols as a preservative is probably a good start. If your levels of formaldehyde are still not decreased dramatically, ventillation changes may be necessary. In terms of controlling the persons exposure to the chemical, improved work practices such as washing specimens is very important. You can probably decrease exposure 100 fold if you adequately wash the material before dissection. I would say work practices are very important parameters that we need to focus on. I consider a cop out all through industry is the use of personnel respiratory protection. By experience over the years we've learned that we can't depend on people to protect themselves. I'm afraid the medical school in Denver

has gone that way already, much to the dismay of the industrial hygienist that works there. They are attempting to use personal respiratory protection as their sole means of protecting their dental and medical students from formaldehyde exposure. My theory and my approach is to apply engineering controls, apply proper work practice techniques and of course product substitution. I would view it as an integrated approach.

Question:

Does formaldehyde gas tend to settle toward the ground?

Dr. BEAULIEU:

The theory that needs to be applied is called effective specific gravity. When you are dealing with low concentrations (one molecule of formaldehyde per million molecules of air) there is very effective diffusing of those molecules. They will diffuse very readily and will not layer. In the case of formaldehyde, the molecular weight is 30 and approximately the same molecular weight collectively of air. The key is always locate the ventillation systems as close to the source of generation as possible.

Question:

What should the air turnover rate be?

Dr. BEAULIEU:

We don't know. It depends on the concentration in the particular laboratory.

Comment by Dr. FREMLING:

A simple way to reduce the formaldehyde vapor concentration for instance with an embalmed dog that has been preserved by standard embalming techniques, would be to follow rinsing with water by rinsing with a 25 % ethylene glycol solution. I would recommend injecting the dog intraperitoneally above and below the diaphragm with a 25 % ethylene glycol solution. The formaldehyde vapors will be lessened considerably. The largest specimens I work with are humans. I think you could embalm a horse by standard embalming procedures with regular embalming fluid and then by secondary perfusion run in 25 % ethylene glycol into the carotid arteries or through the femoral arteries. You would lower the formaldehyde concentration greatly.

Question:

Is it necessary to flush it into the arterial system and out the venous system or just add the ethylene glycol into the arteries?

Dr. SACK:

Most of the time we do not open the venous system because we like to see the clotted blood as a marker for the veins. So we actually have a closed system. Would you then put the 25 % ethylene glycol after the formaldehyde?

Dr. FREMLING:

Yes.

Question:

Do any of the speakers have any actual facts on embalmers or anatomists?

Dr. BLACKWELL:

The data is just not existant. There is one study and it wasn't considered a very good study. There are proposals to do studies on anatomists.

Question:

Dr. BEAULIEU alluded to anatomists wheezing and coughing. Do you have any facts to say that their rate is higher then the normal population?

Dr. BEAULIEU:

The old study by Kerfoot and Mooney of embalmers was pretty shodily done but does indicate obstructive lung disease. I don't have factual data in large populations of anatomists. I think it needs to be done.

Question:

Secondly, you commented as far as respirators and so forth, charcoal and others. Can you state the effectiveness of respirators?

Dr. BEAULIEU:

From what we know of in canister studies and also in sampling studies, formaldehyde does not effectively adsorb onto the surface of charcoal. And of course a paper filter will be of no effect either.

What seems to be fairly effective are the acid gas canisters. Also we know from engineering systems that any of the oxidizers will be good materials for taking formaldehyde out of air. Permanganate for example probably would be a good material to scrub formaldehyde out of air.

Comment by Dr. FREMLING:

Over the years I've become more and more sensitive to formaldehyde. As soon as I walk into the anatomy lab now I get the runny nose and I have a difficult time doing demonstration dissecting because my nose is running all the time. It's gotten bad enough so that I gave up teaching anatomy last year.

Comment by Dr. LOOMIS:

If you are considering compiling data of strictly testamonial nature, I would advise that you are wasting your time. It won't do any good to conduct another study with no controls. There is no question that the compound is an irritant. To come to a conclusion based on testimonial information is not well founded.

Comment by Dr. VENABLE:

Burning eyes is not something that we should put up with in the laboratory. If the student has burning eyes and we don't do something (tell them to get out or suggest something) that wouldn't be reasonable supervision. I have problems with Dr. BEAULIEU's statements about real low levels. By his philosophy you wouldn't hold classes next fall. We know that we are going to experience PPM levels which are liable to cause changes in respiratory function. Do we hold class or not?

Dr. BEAULIEU:

I believe that the integrated approaches at control are prudent. And I think its time.

Comment by Dr. HABEL:

I think we should distinguish between a legal liability and a moral responsibility. There are a lot of legal arguments going on here which I think are irrelevant. We are not working for an industrial corporation. We're teachers. We have a little different kind of obligation than just protecting from legal liability.

Comment from the floor:

The easiest thing to do is to eliminate dissection laboratories.

Dr. HABEL:

I think a great many veterinary administrations would like to eliminate laboratory instruction. You have to be very careful in running to the dean with needs für $500,000 ventilation systems.

Comment by Dr. EVANS:

In the past we have had some sensitive students who can't tolerate the formaldehyde fumes in the lab. We've actually embalmed animals with alcohol, knowing full well that they won't last as long.

Comment by Ms. PARK:

I think the obligation to protect the student from unreasonable risk. Everything you do is going to have some risk. I can walk around in this room and the air that I breath is probably going to be harmful. Ask yourself if it is unreasonable. I don't think you have to go so far as to say no more laboratories. The law is not insensitive to the public good, to scientific research or to economic realities. They don't expect miracles.

Dr. ANDERSON:

We should not leave this symposium with a scare philosophy. All of our departments have done a lot in recent years to reduce exposure to formaldehyde. Nearly all of us use a lower concentration. Some of us use a substitute. I think we should be aware that it can be toxic and that we should do something about the new facilities that are to be constructed. You know I personally don't think the

stuff is extremely toxic, having worked with it for 30 years or more. And I refer again to this group if thousands of people who are gathering in this city who have gone through exposure to formaldehyde and I know of no statistics that state that lung disease or other respiratory disease is more prevailent among veterinarians that it is among anybody else. So I hope you don't go home and scare everybody saying that formaldehyde is extremely toxic without the proper data. I hope that we also in our organization have a committee formed that will continue the work that Dr. RUMPH has started here in investigating this with the help of the most knowledgeable people we can find. As somebody just mentioned, there are too many people willing and anxious to prune down the hours in anatomy and locate them somewhere else. And without laboratory instruction anatomy is not anatomy. Anatomy teaching takes place in the laboratory.